



THE MOSQUITOES OF THREE SELECTED AREAS IN CHEBOYGAN COUNTY, MICHIGAN *

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INTRODUCTION

THE data upon which this paper is based are part of the results of a mosquito survey of three areas in Cheboygan County, Michigan. Larvae and adults were collected from early spring until autumn, and the waters in which the larvae grew were analyzed in an endeavor to learn something of their habitat distribution. Owing to the large amount of time consumed in this type of investigation only three areas were selected for intensive study. Mud Lake, Inverness Township, Cheboygan County, Michigan (T. 37 N., R. 2 W. 1st P. M., Secs. 7 and 18), and Bryant's Bog, Cheboygan County, Michigan (T. 37 N., R. 3 W. 1st P. M., Secs. 29 and 30), were chosen first because of their extensive characteristic bog formations, which impound innumerable pools during the spring and early summer of each year. Later, the eastern shore area (area of the Biological Station of the University of Michigan) of Douglas Lake, Cheboygan County, Michigan, was included. Collections were made during the summers from 1935 to 1939 and the springs from 1937 to 1939. Analyses were made of the waters from which larvae were collected during the spring and summer of 1938 and 1939.

The literature on Michigan mosquitoes is scanty. Pettit (1903) reported a few species from Ingham County. Hinman (1935) confirmed Pettit's record of *Uranotaenia sapphirina* Osten Sacken for Michigan by reporting it from Dexter, Michigan. Dyar (1922) recorded one species that had been sent to him by the Army Medical Board at Camp Custer. Matheson (1924) listed several species from Cheboygan County. Jewell and Brown (1929) reported two species

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from Mud Lake, Cheboygan County. McDaniel (1932) gave a list of species that probably occur in Michigan. Irwin (1941) published a list of forty-three species known to occur in the state.

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SITUATIONS STUDIED

Except for the lakes mentioned all waters studied were shallow. No pools were found having a depth greater than one meter. Their depths ranged from a few centimeters to about one meter. The bottoms were littered with decomposing leaves, twigs, and humus. Each pool commonly contained débris originating from the surrounding vegetation. Most of the waters were strongly colored and highly turbid. All pools began to dry by evaporation as soon as the ice melted in the spring; this caused concentrations of aquatic life and suspended matter.

Mud Lake

Descriptions of Mud Lake by Goe, Erickson, and Woollett (1925), Jewell and Brown (1929), and Welch (1936a) make unnecessary any general account of it here. For present purposes it is desirable to point out that the lake is surrounded by a large mat, grounded at the periphery and floating at its lakeward edges; that this mat is narrow on one side of the lake and very expansive on the other; that most of it is of either the *Chamaedaphne-Sphagnum* or the *Carex* type; and that this great area of mat impounds extensive quantities of water. For descriptions of subdivisions and the physicochemical features of these waters see Irwin (1942).

Bryant's Bog

Bryant's Bog is near the southwest shore of Douglas Lake, Cheboygan County, Michigan. It has been the subject of many studies during the past thirty years. (For bibliography see Welch, 1936b.) For the purposes of this paper it is necessary only to point out that the major portion of the bog is occupied by an extensive mat enclosing at its center a small remnant of the original open water. The mat is for the most part a mixture of sedges and sphagnum moss.

Pools on the mat are similar to those at Mud Lake, but the temporary ones at the margin between the aspens and the mat ("marginal ditch") are larger and deeper and persist longer during spring. For the physicochemical features of the waters of these pools see Irwin (1942).

Biological Station Area

Since the time available did not allow investigation of the entire Douglas Lake area pools in the vicinity of the University of Michigan Biological Station were chosen for study. The area included about two and one-half miles of shore line at the southeast corner of the lake. Physiographically these situations are distinctly different from the bogs. The pools are confined to the shore area and consist mainly of old beach pools flooded by rains and melting ice and snow. In early spring the pools are not in deep shade, but later on the shade becomes dense over most of the water. The pools covered a larger area, were deeper, and were more exposed to the wind than pools in the bog areas. These conditions caused the water to warm slowly but uniformly.

Grapevine Point

Grapevine Point is a wooded tract of land situated west of the station site and extending to the lake. It has beach pools on its northern and western shores which seldom remain throughout the

TABLE I

PHYSICOCHEMICAL DATA FROM POOLS OF THE GRAPEVINE POINT AREA, 1939

Date	Type of pool	Water depth cm.	Temp. C.	pH	O ₂ c.c. per l.	CO ₂ p.p.m.	Methyl orange alkalinity p.p.m.	Conductivity reciprocal megohms
5-11	Beach	60	10.0	6.5	1.7	5.0	122.0	225
5-11	Beach	90	13.0	6.5	3.6	3.1	123.0	220
5-11	Beach	75	12.0	7.3	2.7	9.3	120.0	225
5-11	Beach	25	15.0	7.3	4.6	9.7	94.0	250
5-29	Beach	45	15.0	5.6	1.5	7.4	115.0	290
5-29	Beach	75	15.0	5.9	1.5	5.0	130.0	250
5-29	Beach	45	15.0	5.0	2.0	15.0	101.0	200
5-29	Beach	5	20.0	5.9	0.0	28.0	94.0	200
6-17	Beach	15	15.0	6.0	0.1	10.0	135.0	260
6-17	Beach	45	18.0	7.1	1.2	8.0	140.0	300

summer, but in early spring one on the west shore is about 100 meters long and 15 meters wide and has a maximum depth of 1 meter. The other pools are smaller and shallower. Some on the northern end of the peninsula are completely shaded when the trees are in foliage. Others lying parallel to the shore line are shallower still and, consequently, their waters warm more quickly. The bottoms of the pools, which are composed of sand covered with humus, support trees and shrubs. After drying these areas produce herbs similar to those on the surrounding forest floor. For the physicochemical features of these pools see Table I.

Pine Point

About a mile north of the Station, on the east shore of the lake, a group of four pools occurs on an area called Pine Point. A long semi-permanent one extends northeastward from near shore until it

TABLE II

PHYSICOCHEMICAL DATA FROM POOLS OF THE PINE POINT AREA, 1939

Date	Type of pool	Water depth cm.	Temp. C.	pH	O ₂ c.c. per l.	CO ₂ p.p.m.	Methyl orange alkalinity p.p.m.	Conductivity reciprocal megohms
5-12	Sandpit	45	18.0	5.9	5.2	4.2	8.0	95
5-12	Beach	37	15.0	5.4	1.7	26.2	0.0	45
5-12	Beach	45	21.0	6.0	4.0	13.2	11.0	50
5-30	Sandpit	30	18.0	5.6	4.0	7.5	7.5	57
5-30	Beach	30	18.0	5.8	0.3	10.0	0.0	75
5-30	Beach	37	18.5	5.5	4.4	29.0	3.0	135

merges with a swamp one-half mile distant. It has a maximum depth of 0.5 meter and is a semimarsh supporting trees, shrubs, and emergent aquatic plants. Another depression, formed by excavation of sand, contains water during the greater part of spring. The remaining two are beach pools. One lies parallel to the shore line, is nearly one meter deep, and is so overgrown with shrubs that it is shaded even before the leaves are out. The other is not more than 30 cm. deep in early spring and soon dries, although it covers a considerable area. For the physicochemical features of these pools see Table II.

DISCUSSION OF SPECIES

Genus *Aedes* Meigen

Adult mosquitoes of the genus *Aedes* first appeared about the middle of May and by the last of the month were very numerous in wooded regions. They migrated from their breeding pools to all surrounding areas, but remained only where there were an abundance of green vegetation and protection from wind. During the last of May and the first of June many species entered houses, but did not remain, as do some species of *Anopheles*. Many species occurred in the pools throughout the remainder of spring and summer. Usually there was but one brood a year, and the number of adults decreased rapidly as the season progressed. Lights seemed to attract them very little, though they would cluster around a warm dish as eagerly as around an animal and would try energetically to insert their mouth parts. They were more inclined to attack when the humidity was high and the air warm. Except during unusually mild nights in early spring their attacks stopped about 10:00 P.M. and began about 4:00 A.M., unless they were disturbed. As the morning advanced beyond eight o'clock they retreated to the shaded and more humid areas of trees, where they stayed until late afternoon.

1. *A. aboriginis* Dyar. — Rare for this region; three females taken at Bryant's Bog, May 28, and two at Mud Lake, June 12, 1938; no larvae or males found.

2. *A. aurifer* (Coquillett). — One adult taken at Mud Lake, July 12, 1937; two larvae collected from large mat pools, Mud Lake, May 14, 1938.

Dyar (1922; 1928) states that the larvae live in cranberry bogs particularly, but apparently this is not true for northern Michigan.

Immature specimens of *A. aurifer* taken from waters with principal chemical features as follows: pH, 5.5; dissolved oxygen, 1.5 c.c. per l.; free carbon dioxide, 2.7 p.p.m.; methyl orange alkalinity, 20.0 p.p.m.; conductivity, 42 reciprocal megohms.

3. *A. canadensis* (Theobald). — Adults abundant; taken as early as May 14, 1938, and as late as August 21, 1938. Larvae very abundant and in every natural situation investigated; greatest concentrations in pools on sphagnum mats; earliest seasonal record, April 30, 1938, latest, August 6, 1937; the later seasonal collections made from cold permanent swamp pools.

Immature specimens of *A. canadensis* taken from waters with principal chemical features as follows: pH, 4.0–7.3; dissolved oxygen, 0.0–8.9 c.c. per l.; free carbon dioxide, 1.8–36.5 p.p.m.; methyl orange alkalinity, 0.0–130.0 p.p.m.; conductivity, 37–290 reciprocal megohms.

4. *A. cinereus* Meigen. — Very common; earliest seasonal collections of adults at Mud Lake and in Douglas Lake area, May 29, 1937 and 1939; found during summer; latest seasonal record, August 21, 1938; never taken far from breeding places; usually fly low, about one meter above ground.

First collections of fourth instar larvae taken 10–14 days later than earliest maturing *Aedes* larvae; found in all natural pools except more acid ones of Bryant's Bog mat; most numerous in shallow pools or at margins of deeper ones; earliest seasonal record, May 8, 1939, latest, June 24, 1937.

Immature specimens of *A. cinereus* taken from waters with principal chemical features as follows: pH, 5.0–7.3; dissolved oxygen, 0.0–4.7 c.c. per l.; free carbon dioxide, 1.5–19.5 p.p.m.; methyl orange alkalinity, 0.0–130.0 p.p.m.; conductivity, 42–290 reciprocal megohms.

5. *A. communis* (DeGeer). — Abundant; earliest seasonal record for adults, May 14, 1938, latest, August 3, 1935 and 1936; specimens taken throughout each summer.

Larvae abundant; in all natural pools, particularly in early-drying pools among aspens, beach pools of Douglas Lake area, and shallow swamp pools; absent in pools with abundance of filamentous algae; earliest seasonal record, April 30, 1938, latest, June 29, 1937; scarce during June; all records for June from cool swamp pools.

Immature specimens of *A. communis* taken from waters with principal chemical features as follows: pH, 5.5–7.3; dissolved oxygen, 0.0–5.2 c.c. per l.; free carbon dioxide, 1.5–26.2 p.p.m.; methyl orange alkalinity, 0.0–122.0 p.p.m.; conductivity, 37–225 reciprocal megohms.

6. *A. diantaeus* Howard, Dyar, & Knab. — Two females taken at Mud Lake, June 12, 1937. Larvae fairly common; earliest seasonal record, April 30, 1938, latest, May 28, 1938.

Immature specimens of *A. diantaeus* taken from waters with principal chemical features as follows: pH, 4.0–6.0; dissolved oxygen, 0.6–5.2 c.c. per l.; free carbon dioxide, 1.9–26.9 p.p.m.; methyl

orange alkalinity, 0.0–34.0 p.p.m.; conductivity, 45–155 reciprocal megohms.

7. *A. excrucians* (Walker). — Adults abundant throughout areas studied; invaded houses in evenings and early mornings, but restricted to wooded regions during day; will attack day or night; earliest seasonal record, May 30, 1939; adults still abundant August 21, 1938.

Larvae common in all natural pools examined, but more abundant in partly shaded ones; earliest seasonal record, April 30, 1938, latest, May 29, 1937.

Immature specimens of *A. excrucians* taken from waters with principal chemical features as follows: pH, 4.0–6.5; dissolved oxygen, 0.0–8.9 c.c. per l.; free carbon dioxide, 1.5–19.5 p.p.m.; methyl orange alkalinity, 0.0–123.0 p.p.m.; conductivity, 37–220 reciprocal megohms.

8. *A. fitchii* (Felt & Young). — Most abundant adult mosquitoes in areas studied; are restricted to the wooded regions during day, but migrate to all parts at night; earliest seasonal record, May 29, 1939, latest, August 21, 1938.

Larvae rare within areas investigated; only four specimens taken, three from mat pools of Mud Lake (1, May 8, 1937; 2, May 14, 1938) and one from beach pool, Pine Point, Douglas Lake area, May 12, 1939.

Immature specimens of *A. fitchii* taken from waters with principal chemical features as follows: pH, 5.5–6.1; dissolved oxygen, 1.4–4.0 c.c. per l.; free carbon dioxide, 2.7–13.2 p.p.m.; methyl orange alkalinity, 11.0–20.0 p.p.m.; conductivity, 42–50 reciprocal megohms.

9. *A. flavescens* (Müller). — Adults not found in areas studied; ten larvae taken in beach pools of Biological Station area; earliest seasonal record, May 12, 1939, latest, May 29, 1939.

Immature specimens of *A. flavescens* taken from waters with principal chemical features as follows: pH, 5.6–6.1; dissolved oxygen, 1.5–4.0 c.c. per l.; free carbon dioxide, 5.0–13.2 p.p.m.; methyl orange alkalinity, 11.0–130.0 p.p.m.; conductivity, 50–290 reciprocal megohms.

10. *A. impiger* (Walker). — Rare; adults found in areas investigated during morning and afternoon in wooded sections, but about buildings of Biological Station only in evenings; earliest seasonal record, May 14, 1938, latest, June 12, 1937.

One larva only taken at Mud Lake, from large mat pool exposed to sun; none found at Bryant's Bog; several collected from beach pool at Grapevine Point, Biological Station area; earliest seasonal record, May 11, 1939, latest, May 29, 1937.

Chemical records of water made from beach pool: pH, 7.3; dissolved oxygen, 2.7 c.c. per l.; free carbon dioxide, 9.3 p.p.m.; methyl orange alkalinity, 120.0 p.p.m.; conductivity, 225 reciprocal megohms.

11. *A. implacabilis* (Walker). — The writer found it impossible to separate the females of *A. implacabilis* from those of *A. punctor* (Kirby). Specimens of both species were reared, but no distinguishing characters for the females could be found. To judge from the proportionate number of larvae of the two species, females of *A. implacabilis* must have been common.

Larvae plentiful at Mud Lake and Bryant's Bog; not found in Biological Station area; first to mature in spring; occurred mainly in sunlit pools; few in shaded swamp pools; comprised about 6 per cent of all larvae taken at Mud Lake and approximately 5 per cent of those at Bryant's Bog; earliest seasonal record, April 30, 1938, latest, May 22, 1937.

Immature specimens of *A. implacabilis* taken from waters with principal chemical features as follows: pH, 4.0–6.1; dissolved oxygen, 1.0–4.7 c.c. per l.; free carbon dioxide, 1.9–19.5 p.p.m.; methyl orange alkalinity, 0.0–20.0 p.p.m.; conductivity, 37–155 reciprocal megohms.

12. *A. intrudens* Dyar. — Adults abundant throughout spring and summer; earliest seasonal record, May 12, 1939, latest, August 10, 1935.

There is a wide variation in the characters used for taxonomy. About 50 per cent of adults collected lacked the lower mesepimeral bristles given as a character in the key by Matheson (1929).

Larvae abundant locally; absent at Mud Lake; not taken at Bryant's Bog during spring of 1937, but abundant in that area in pools among aspens and on mat during spring of 1938; abundant in beach pools at Pine Point, Douglas Lake, 1939; earliest record, April 30, 1938, latest, May 12, 1939.

Immature specimens of *A. intrudens* taken from waters with principal chemical features as follows: pH, 4.0–5.9; dissolved oxygen, 0.0–5.2 c.c. per l.; free carbon dioxide, 2.4–26.2 p.p.m.; methyl

orange alkalinity, 0.0–8.0 p.p.m.; conductivity, 45–110 reciprocal megohms.

13. *A. lateralis* (Meigen). — Adults fairly common; earliest seasonal record, May 14, 1938, latest, July 30, 1937; both males and females taken throughout areas studied; adults were small, about the size of those of *A. canadensis* (Theobald), yet, contrary to the statement by Dyar (1922), not able to crawl through ordinary window screens.

First mature larvae found at Bryant's Bog and Mud Lake, May 8, 1937, and in Biological Station area, May 12, 1939; latest seasonal collection, May 29, 1939. Larvae absent from more acid waters of Bryant's Bog mat. Dyar (1922) states they are found in shaded pools, but most of those collected by the writer were from sunlit pools. However, a few specimens were taken in shaded and partly shaded areas.

Immature specimens of *A. lateralis* taken from waters with principal chemical features as follows: pH, 5.4–6.0; dissolved oxygen, 1.7–5.2 c.c. per l.; free carbon dioxide, 4.2–26.3 p.p.m.; methyl orange alkalinity, 0.0–11.0 p.p.m.; conductivity, 45–155 reciprocal megohms.

14. *A. pullatus* (Coquillett). — Rare; two females taken at Bryant's Bog, May 14, 1938, and May 22, 1937; one female at Mud Lake, May 5, 1938.

One larva found in large mat pool at Mud Lake, May 14, 1938; taken from water with principal chemical features as follows: pH, 5.5; dissolved oxygen, 1.4 c.c. per l.; free carbon dioxide, 2.7 p.p.m.; methyl orange alkalinity, 20.0 p.p.m.; conductivity, 42 reciprocal megohms.

15. *A. punctor* (Kirby). — Owing to the writer's inability to distinguish females of *A. punctor* from those of *A. implacabilis* in field collections of adults (see No. 11) the exact magnitude of the populations of each species was uncertain. *A. punctor* females of known identity were secured only by rearing them from previously identified larvae.

Adults apparently abundant; taken in wooded regions day or night; found in and around buildings only during early morning and evening; among first to emerge in spring; earliest seasonal record, May 14, 1938, latest, August 2, 1938.

Larvae abundant in all situations at Bryant's Bog and Mud Lake;

not found in Biological Station area; numerous in cold, shaded swamp pools as well as in exposed pools of mat and aspens; later seasonal records from the cold, shaded pools; earliest seasonal record, April 30, 1938, latest, July 2, 1937.

Immature specimens of *A. punctor* were taken from waters with principal chemical features as follows: pH, 4.2–6.1; dissolved oxygen, 0.0–8.9 c.c. per l.; free carbon dioxide, 1.5–19.5 p.p.m.; methyl orange alkalinity, 0.0–48.0 p.p.m.; conductivity, 35–170 reciprocal megohms.

16. *A. riparius* Dyar & Knab. — Rare; only one male (May 22, 1937) and one female (July 7, 1938) taken; larvae not found.

17. *A. spenceri* (Theobald). — Rare; one female taken at Mud Lake, July 30, 1937; one larva collected in large mat pool, Mud Lake, May 14, 1938; one larva from mat pool, Bryant's Bog, May 22, 1937. Other specimens taken from areas bordering localities noted here.

One larva taken from water with principal chemical features as follows: pH, 5.5; dissolved oxygen, 1.4 c.c. per l.; free carbon dioxide, 2.7 p.p.m.; methyl orange alkalinity, 20.0 p.p.m.; conductivity, 42 reciprocal megohms. Chemical analyses of water containing other larva not available.

18. *A. sticticus* (Meigen). — Adults rare; not taken beyond shelter of woods except in evening; earliest seasonal record, May 14, 1938, latest, August 2, 1938.

One larva found, May 14, 1938, in shaded permanent swamp pool at Mud Lake, the principal chemical features of which were: pH, 5.0; dissolved oxygen, 0.0 c.c. per l.; free carbon dioxide, 1.5 p.p.m.; methyl orange alkalinity, 20.0 p.p.m.; conductivity, 55 reciprocal megohms.

19. *A. stimulans* (Walker). — Adults abundant throughout spring and summer; earliest seasonal record, May 29, 1939, latest, August 21, 1938; specimens taken in wooded areas day or night after the vegetation had been disturbed; found about buildings and in houses only in early morning and evening hours; commonly associated with *A. fitchii* and *A. excrucians*.

Larvae abundant in beach pools at Grapevine Point and Pine Point, Biological Station area; one specimen only taken in large mat pool at Mud Lake; larvae of thirteen other species found in association with larvae of this species; earliest seasonal record, May 11, 1939, latest, May 29, 1937.

Immature specimens of *A. stimulans* taken from waters with principal chemical features as follows: pH, 5.4–7.3; dissolved oxygen, 1.7–4.6 c.c. per l.; free carbon dioxide, 5.0–26.2 p.p.m.; methyl orange alkalinity, 0.0–122.0 p.p.m.; conductivity, 45–250 reciprocal megohms.

20. *A. trichurus* (Dyar). — Common; adults appear early in spring and are present throughout summer; enter houses in early spring; found in wooded regions until early summer, when their numbers decrease noticeably; earliest seasonal record, May 14, 1938, latest, August 10, 1935.

Larvae absent in more acid pools of Bryant's Bog mat; present in most parts of areas studied; earliest seasonal record, April 30, 1938, latest, May 14, 1938.

Immature specimens of *A. trichurus* taken from waters with principal chemical features as follows: pH, 4.2–7.3; dissolved oxygen, 0.0–4.6 c.c. per l.; free carbon dioxide, 1.5–26.2 p.p.m.; methyl orange alkalinity, 0.0–123.0 p.p.m.; conductivity, 37–250 reciprocal megohms.

21. *A. vexans* (Meigen). — Adults not common; fly low, remaining close to ground; taken at various times of day; enter houses only at night; earliest seasonal record, June 26, 1938, latest, August 21, 1938.

Larvae taken in two collections from permanent swamp pools at Mud Lake, June 12, 1937, and from deep shaded pool on mat at Bryant's Bog, May 8, 1937; no chemical analyses of water available.

Unidentified *Aedes* larvae: Two groups of larvae that could not be identified as belonging to any known species were taken in these areas. In all keys these larvae were traced to *A. diantaeus* Howard, Dyar, & Knab, but the descriptions of that species do not fit. Since they have characters so strikingly distinct the following descriptions are given. Reared adults were not secured.

22. *Aedes* sp. — Two specimens collected from pools among aspens at Bryant's Bog, May 22, 1937; water analyses not available.

Description. — Head: wider than long. Antennae: longer than head, slightly enlarged basally, spines fairly large and scattered, 4-haired tuft at middle. Head hairs: upper, 3–4; lower, 3, ante-antennal tuft of 2–4 hairs. Lateral abdominal hairs: double on first segment, single on 2–6. Scales of eighth abdominal segment: 11–12, arranged in triangular patch, each scale with long central spine.

Anal segment: longer than wide, not ringed by large plate, dorsal brush of 2 tufts and 2 long hairs, ventral brush of well-developed tufts. Air tube: three times as long as wide, tapering, pecten before middle with 3 detached teeth, pecten tuft of 5-6 hairs located at middle. Anal gills: about twice as long as anal segment, tapering to sharp point.

23. *Aedes* sp. — These specimens were collected from large mat pools at Bryant's Bog and Mud Lake. The earliest seasonal record was April 30, 1938, latest, May 14, 1938. Larvae taken during 1937 and 1939.

All collections of this species were from waters with principal chemical features as follows: pH, 4.0-5.9; dissolved oxygen, 3.4-8.9 c.c. per l.; free carbon dioxide, 2.4-7.5 p.p.m.; methyl orange alkalinity, 0.0-48.0 p.p.m.; conductivity, 40-155 reciprocal megohms.

Description. — Head: rounded, wider than long. Antennae: longer than head, coarsely spined toward tip, 2-haired tuft at middle. Head hairs: upper and lower 1-2 per trichopore, anteantennal tuft of 2-3 hairs. Lateral abdominal hairs: double on segments 1 and 2, single on 3-6. Scales of eighth abdominal segment: 5-7, arranged in one irregular row, sometimes one or two conspicuously out of line; each scale with long central spine. Anal segment: longer than wide, not completely ringed by plate, dorsal brush with one pair of long hairs and one pair of tufts consisting of 3-4 hairs each, ventral brush well developed. Air tube: at least four times as long as wide, tapering, pecten reaching middle and ending in 3 enlarged detached teeth, pecten tuft of 3-5 small hairs located beyond pecten and middle. Anal gills: pointed, twice as long as anal segment. All hairs of larva nearly uniform in diameter from base to apex, decidedly blunt at apex.

Genus *Anopheles* Meigen

The genus *Anopheles* is represented by three species. There are situations within the county that are well adapted for the growth of Anophelini, but they do not lie within the areas under discussion. Most permanent pools harbor a few larvae, however. Specimens were occasionally taken from beach, swamp, and mat pools, but most frequently from the lakeward margin of the mats. Larvae were not found before the middle of May. In these areas no larvae were collected from water totally exposed to the sun.

24. *A. maculipennis* Meigen. — Most common species found in areas studied; earliest seasonal record for adults, June 18, 1939.

Larvae in all natural pools during summer; specimens taken in margins of Mud Lake and Bryant's Bog; also in mat pools, permanent swamp pools, and beach pools in Biological Station area; earliest seasonal record, May 28, 1938, when only young instars were found; larvae present throughout summer.

Immature specimens of *A. maculipennis* taken from waters with principal chemical features as follows: pH, 4.8–5.1; dissolved oxygen, 0.0–0.7 c.c. per l.; free carbon dioxide, 1.5–2.1 p.p.m.; methyl orange alkalinity, 9.0–14.0 p.p.m.; conductivity, 65–70 reciprocal megohms.

25. *A. punctipennis* (Say). — Rare; scattered records of adults obtained throughout summers; earliest seasonal collection of adults, July 7, 1935.

Larvae present scantily in most natural pools in June, July, and August; earliest seasonal collection was of early instars from large mat pools at Mud Lake, May 28, 1938; occasional specimen in lake-ward edges of mat in both Mud Lake and Bryant's Bog.

Immature specimens of *A. punctipennis* taken from waters with principal chemical features as follows: pH, 5.1–6.2; dissolved oxygen, 0.0–0.7 c.c. per l.; free carbon dioxide, 1.8–2.1 p.p.m.; methyl orange alkalinity, 0.0–114.0 p.p.m.; conductivity, 47–290 reciprocal megohms.

26. *A. walkeri* Theobald. — Very rare; one female taken at Mud Lake, August 24, 1938; adults common in localities but a few miles distant.

Genus *Culex* Linnaeus

There are four species of the genus *Culex* in the areas studied. Adults appeared about the last of June and were usually present until late autumn.

27. *C. apicalis* Adams. — Abundant; hide in dark recesses of stumps and logs, but most common on green vegetation; not found in or about buildings.

Larvae abundant in all pools after early June; earliest seasonal record, May 28, 1938; present in swamp pools, mat pools, beach pools, and the margins of Mud Lake and Bryant's Bog during June, July, and August.

Immature specimens of *C. apicalis* taken from waters with principal chemical features as follows: pH, 5.0–6.2; dissolved oxygen,

0.0–3.3 c.c. per l.; free carbon dioxide, 1.5–17.5 p.p.m.; methyl orange alkalinity, 0.0–130.0 p.p.m.; conductivity, 47–290 reciprocal megohms.

There is a variation in the number of head hairs of the larvae taken here. Many have two hairs at each trichopore; other specimens were found with hairs arranged in all possible combinations of one to two at each trichopore for both upper and lower head hairs. Repeatedly specimens with such variations were reared. Adults, male and female, coming from these larvae could not be distinguished from those coming from larvae with but one hair to a trichopore.

28. *C. pipiens* Linnaeus. — Rare; taken only from large mat pools at Mud Lake, June 26, 1938. The only adults secured were reared from this collection. Principal chemical features of water were: pH, 6.2; dissolved oxygen, 0.7 c.c. per l.; free carbon dioxide, 1.8 p.p.m.; methyl orange alkalinity, 114.0 p.p.m.; conductivity, 290 reciprocal megohms.

29. *C. restuans* Theobald. — Abundant; adults found in all localities from last of June to early autumn; earliest seasonal record, June 28, 1937.

Larvae abundant in all quiet natural pools and artificial containers; earliest seasonal record, May 28, 1939, when larvae were taken from large mat pool, Mud Lake; specimens collected almost at will after middle of June from any water supply; found in waters at margins in Mud Lake and Bryant's Bog, in both large and small mat pools, and intermittently in the drain basin of the Biological Station septic tank. When oiling was neglected the water in this basin, rich in organic matter, produced great numbers of mosquitoes. Actual count showed 256 larvae in one cup of the water. By the use of traps to capture emerging adults the pool was found to be producing at least 75 adults per square foot (154.8 sq. cm.) of water surface per hour.

Immature specimens of *C. restuans* taken from water with principal chemical features as follows: pH, 5.0–6.6; dissolved oxygen, 0.4–4.3 c.c. per l.; free carbon dioxide, 1.8–30.5 p.p.m.; methyl orange alkalinity, 6.0–11.4 p.p.m.; conductivity, 60–290 reciprocal megohms.

30. *C. salinarius* Coquillett. — Two larvae found in beach pool at Grapevine Point, Biological Station area, July 20, 1936; adults reared from the larvae, no analyses of water available.

Genus *Mansonia* Blanchard

There was only one representative of the genus *Mansonia*.

31. *M. perturbans* (Walker) is a common mosquito. Specimens could be captured any time during the day or night. They were taken throughout each summer for five years. The writer's earliest seasonal record is June 25, 1939; latest, August 18, 1939. No larvae were found.

Genus *Theobaldia* Neveu-Lemaire

Three species of the genus *Theobaldia* were found within the three areas.

32. *T. impatiens* (Walker). — Rare; one female taken at Mud Lake, August 21, 1938; larvae collected once from large mat pool at Mud Lake, June 26, 1938; adults reared from these larvae; associated with *Anopheles maculipennis*, *Culex apicalis*, *C. restuans*, *C. pipiens*, and *Theobaldia inornata*.

The principal chemical features of water were: pH, 6.2; dissolved oxygen, 0.7 c.c. per l.; free carbon dioxide, 1.8 p.p.m.; methyl orange alkalinity, 114.0 p.p.m.; conductivity, 290 reciprocal megohms.

33. *T. inornata* (Williston). — Rare; two larvae taken from large mat pool at Mud Lake, June 26, 1938, and reared. The principal chemical features of water were: pH, 6.2; dissolved oxygen, 0.7 c.c. per l.; free carbon dioxide, 1.8 p.p.m.; methyl orange alkalinity, 114.0 p.p.m.; conductivity, 290 reciprocal megohms.

34. *T. morsitans* (Theobald). — Rather common at Mud Lake; occasional specimens taken in Biological Station area; none found at Bryant's Bog. Adults could not be induced to eat blood meals, but were captured at their resting places, on the bases of trees and stumps near breeding pools.

Larvae common in all deeper pools of Mud Lake mat and swamp; a few taken from shaded portions of beach pool at Pine Point, Douglas Lake; earliest seasonal record (early instar larvae), Mud Lake, May 12, 1939, latest (mature larvae), August 6, 1937.

Immature specimens of *T. morsitans* taken from water with principal chemical features as follows: pH, 4.9–6.0; dissolved oxygen, 0.0–8.9 c.c. per l.; free carbon dioxide, 1.5–36.5 p.p.m.; methyl orange alkalinity, 0.0–36.0 p.p.m.; conductivity, 45–170 reciprocal megohms.

Genus *Wyeomyia* Theobald

One species of the genus *Wyeomyia* occurs in the region.

35. *W. smithii* (Coquillett). — Common in bog areas; adults emerge throughout spring and summer; larvae occur continuously in pitchers of *Sarracenia purpurea*. Analyses not made of the water in these plants.

ANALYSIS OF SPECIES LIST

Six genera and 35 species of the family Culicidae, subfamily Culicinae, were collected in these areas. The species are distributed among the genera as follows: *Aedes*, 23; *Anopheles*, 3; *Culex*, 4; *Mansonia*, 1; *Theobaldia*, 3; and *Wyeomyia*, 1. Six of the 8 genera and 35 of the 45 species native to the state occur here. Since 75 per cent of the genera and about 80 per cent of the species reported for the state were taken in the three areas it seems that the waters in them, when conditions are favorable, are well adapted to mosquito production.

At times *Uranotaenia sapphirina* Osten Sacken was abundant in adjacent bog situations, and *Culex tarsalis* Coquillett and *Theobaldia incidens* Thomson were taken near by, but not from these areas. Adults of *Mansonia perturbans* occurred commonly throughout the areas, but no larvae were collected. It seems possible that at times these four species might also be produced in the areas studied.

LARVAL ASSOCIATION

Table III shows the association of larvae as found in the three areas studied. The figures represent the number of times a species was collected in the same pool with the other species.

SUMMARY

1. A list of the species of mosquitoes found in the three areas studied is presented. Six genera and thirty-five species of Culicidae, subfamily Culicinae, were collected.

2. Data are given showing the larval association in the three areas.

3. Contrary to previous taxonomic descriptions, many adult specimens of *Aedes intrudens* lack lower mesepimeral bristles, and numerous larvae of *Culex apicalis* show a variation of 1-2 head hairs per trichopore.

4. The variational ranges of the principal chemical features of the waters in which larval specimens of each species (some exceptions) grew are presented.

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